

ADT PLM

Programmer's Learning Machine

Matthieu Nicolas

IJD Seminar, 2016-02-02

1 Presentation of PLM

- Purposes
- Demo
- About PLM
- Architecture

2 To a web app

- Goals
- PLM as a library
- Outcome

3 Assessment of user's code

- Challenges
- Extraction of the execution component
- Docker

4 Result

5 Next steps

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Presentation of PLM

Purposes

- Application to learn programming.

Presentation of PLM

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- Allows students to progress at their own speed...

Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.

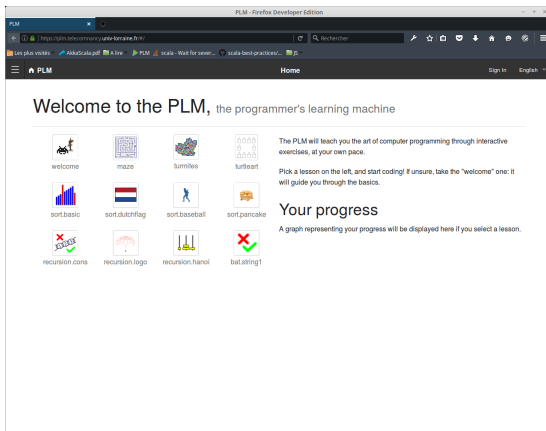
Presentation of PLM

Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.
- Used at TELECOM Nancy since 2008.

Presentation of PLM

Quick demo



- Available at <https://plm.telecomnancy.univ-lorraine.fr>

Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/la/lessons/maze/maze-wallfollower/maze-wallfollower-maze

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Maze / WallFollowerMaze Se connecter Java Français

World Objective



Résultats de l'exécution

Éditeur de code:

```
public void run() {  
    // ...  
}
```

Cas de tests:

Another labyrinth Labyrinth

Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/.../recursion/hanoi/hanoi.lessons/hanoi.Hanoi

Recherche

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PLM Recursion.hanoi / HanoiBoard Se connecter Java Français

World Objective

0 Move



Résultats de l'exécution

Cas de tests:

solve(0,1,2) solve(1,2,0) solve(2,0,1)

Éditeur de code: Réinitialiser API

```
public void hanoi(int height, int src, int other, int dest) {  
    ...  
}
```

Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/ta/lessons/recursion/logo/recursion/logo/tree.Tre

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Recursion.logo / Tree Se connecter Java Français

World Objective



Éditeur de code: Réinitialiser API

```
public void tree(int steps, double length, double angle, double shrink) {  
    // ...  
}
```

Résultats de l'exécution

Cas de tests:

tree(10,100,90,0.68)	▶	tree(10,80,45,0.7)	▶
tree(7,75,15,0.8)	▶	tree(7,75,30,0.8)	▶

Presentation of PLM

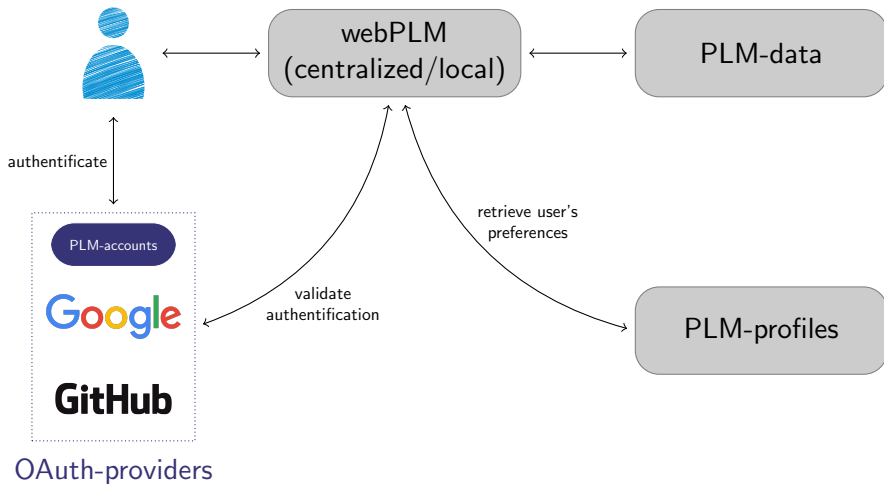
Languages and programming languages

- Available languages:
 - English
 - French
 - Brazilian Portuguese
- Supported programming languages:



Presentation of PLM

Application's architecture



Outline

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To a web app

Evolution of the project

- Formerly a fat client
 - Written in Java

To a web app

Evolution of the project

- Formerly a fat client
 - Written in Java
- Switch to a web application
 - Server implemented in Scala using *PlayFramework*
 - User interface written in Javascript using *AngularJS* and *Foundation*



To a web app

Motivations

- More user-friendly
- Aim to setup SPOC¹ and MOOC²
- But don't have the time and means for a reboot

¹Small Private Online Course

²Massive Open Online Course

To a web app

Refactoring PLM

- Implemented a headless version of PLM: *PLM-engine*
 - Provide all PLM's content and methods
 - But without a user interface

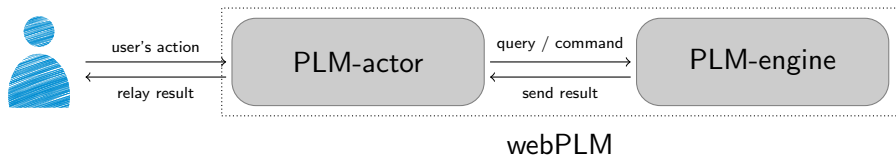
To a web app

Implementing the server

- Designed a communication protocol between the server and the client
 - User's actions sent to server as JSON messages
- Only need to implement an interpreter
 - Parse messages received from the client
 - Query or command PLM-engine according to the message
 - Send back result or acknowledgement to the client

To a web app

Interactions between components



To a web app

Results

- Build quickly a web application from the fat client...
- ... but can't share common ressources among users

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Assessment of user's code

Limits

- Run on the same machine, same JVM

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops
- And from more malicious "mistakes"?
 - Infinite thread creation
 - Endless file creation

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
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- And from more malicious "mistakes"?
 - Infinite thread creation
 - Endless file creation
- And from *System.exit(whatever)*?

Assessment of user's code

Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
 - Infinite loops
- And from more malicious "mistakes"?
 - Infinite thread creation
 - Endless file creation
- And from *System.exit(whatever)*?
- Scalability issues

Assessment of user's code

Delegate execution to workers

- Called *Judges* in the litterature
- Use PLM-engine as well
- Workflow:
 - Retrieve an execution request
 - Parse the request to extract parameters
 - Configure PLM-engine according to them
 - Run the user's code
 - Send back result to webPLM

Assessment of user's code

Message queues

- Message-driven architecture
- Help to implement:
 - Producer/Consumer pattern
 - Request/Response pattern
- Different reliability patterns of the message processing:
 - Only one worker
 - At least one worker
 - All workers

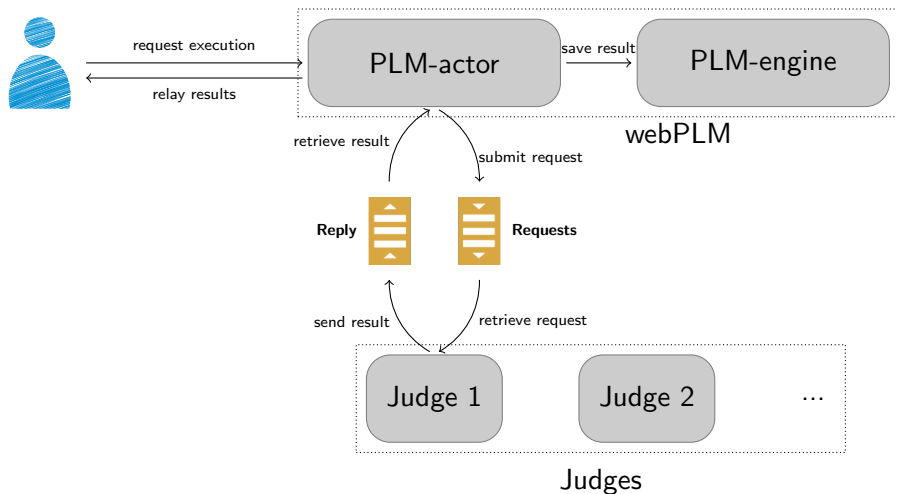
Assessment of user's code

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Assessment of user's code

Architecture with judges



Assessment of user's code

Pros and cons

- Pros:
 - Allow to run code without impacting webPLM's performances
 - Meet the scalability requirements

Assessment of user's code

Pros and cons

- Pros:

- Allow to run code without impacting webPLM's performances
- Meet the scalability requirements

- Cons:

- Make sure to use the right version of PLM-engine
- Need to deploy them easily
- Should restart them after each execution
- Have to restrict their resources usage

Assessment of user's code

Docker

- Lightweight virtualization tool
- Build image of your application
- Run containers based on images



Assessment of user's code

Example of Dockerfile

- Dockerfiles describe how to set up the application

```
Dockerfile
1 FROM node:latest
2
3 MAINTAINER Matthieu Nicolas, matthieu.nicolas@inria.fr
4
5 WORKDIR /app
6
7 # Required for PhantomJS
8 RUN apt-get install -y bzip2
9
10 # Install Mean.JS Prerequisites
11 RUN npm install -g grunt-cli
12 RUN npm install -g bower
13
14 # Install Mean.JS packages
15 ADD package.json /app/package.json
16 RUN npm install
17
18 # Manually trigger bower. Why doesnt this work via npm install?
19 ADD .bowerrc /app/.bowerrc
20 ADD bower.json /app/bower.json
21 RUN bower install --config.interactive=false --allow-root
22
23 # Make everything available for start
24 ADD . /app
25
26 ENV NODE_ENV production
27
28 # Port 3000 for server
29 # Port 35729 for livereload
30 EXPOSE 3000 35729
31 CMD ["grunt"]
```

- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

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1 FROM node:latest~
2 ~
3 MAINTAINER Matthieu Nicolas, matthieu.nicolas@inria.fr~
4 ~
5 WORKDIR /app~
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- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes
 - Links between containers

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes
 - Links between containers
 - Environment variables
 - Runtime constraints on resources
 - Restart policies
 - And a **lot more**

Assessment of user's code

More about *docker run*

- Can also manage
 - Ports
 - Volumes
 - Links between containers
 - Environment variables
 - Runtime constraints on resources
 - Restart policies
 - And a **lot more**
- Commands can become quite complex

```
docker run -p 443:9443 -link plm-accounts:accounts -v  
~/webPLM/logs/:/app/webplm-dist/logs webPLM
```

Assessment of user's code

Docker-compose

- Tool to easily deploy multi-containers applications

```
docker-compose.yml
1  nginx:
2    image: nginx
3    ports:
4      - "80:80"
5
6  messagequeue:
7    image: rabbitmq:3-management
8    ports:
9      - "5672:5672"
10     - "15672:15672"
11
12  plm:
13    image: webplm
14    volumes:
15      - ~/.plm:/root/.plm
16      - ~/webPLM/logs:/app/webplm-dist/logs
17    ports:
18      - "443:9443"
19    environment:
20      GITHUB_CLIENT_SECRET:
21      GOOGLE_CLIENT_SECRET:
22      PLMACCOUNTS_CLIENT_SECRET:
23      GITHUB_ACCESS_TOKEN:
24    links:
25      - accounts
26      - profiles
27      - messagequeue:messageq
28
29  accounts:
30    image: plm-accounts
31
32  profiles:
33    image: plm-profiles
34    ports:
35      - "8080:3000"
36    links:
37      - db
38
39  db:
40    image: mongo
41    volumes:
42      - ~/.mongodb/data:/data/db
43    ports:
44      - "27017:27017"
```

- Deploy environment with *docker-compose up*

```

1  nginx:~
2    --image: nginx
3    --ports:~
4    - "80:80"~
5    ~
6  messagequeue:~
7    --image: rabbitmq:3-management~
8    --ports:~
9    - "5672:5672"~
10   - "15672:15672"~
11   ~
12  plm:~
13    --image: webplm~
14    --volumes:~
15    - "~/.plm:/root/.plm"~
16    - "~/webPLM/logs:/app/webplm-dist/logs"~
17    --ports:~
18    - "443:9443"~
19    --environment:~
20    - GITHUB_CLIENT_SECRET:~
21    - GOOGLE_CLIENT_SECRET:~
22    - PLMACCOUNTS_CLIENT_SECRET:~
23    - GITHUB_ACCESS_TOKEN:~
24    --links:~
25    - accounts
26    - profiles
27    - messagequeue:messageq~
28    ~
29  accounts:~
30    --image: plm-accounts~

```

```

20    - GITHUB_CLIENT_SECRET:~
21    - GOOGLE_CLIENT_SECRET:~
22    - PLMACCOUNTS_CLIENT_SECRET:~
23    - GITHUB_ACCESS_TOKEN:~
24    --links:~
25    - accounts
26    - profiles
27    - messagequeue:messageq~
28    ~
29  accounts:~
30    --image: plm-accounts~
31    --ports:~
32    - "9000:3000"~
33    --links:~
34    - db~
35    ~
36  profiles:~
37    --image: plm-profiles~
38    --ports:~
39    - "8080:3000"~
40    --links:~
41    - db~
42    ~
43  db:~
44    --image: mongo~
45    --volumes:~
46    - "~/mongodb/data:/data/db"~
47    --ports:~
48    - "27017:27017"~
49    ~

```

Assessment of user's code

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431  db:
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433    volumes:
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1012      - "27017:27017"
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1014  links:
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1016    - profiles
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1025  db:
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1027    volumes:
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1478      - ~/mongodb/data:/data/db
1479    ports:
1480      - "27017:27017"
1481
1482  links:
1483    - accounts
1484    - profiles
1485    - messagequeue:messageq

```

Assessment of user's code

Docker in our case

- Deploy easily all components
- Restart judges automatically
- Limit users' mischiefs

Outline

1 Presentation of PLM

- Purposes
- Demo
- About PLM
- Architecture

2 To a web app

- Goals
- PLM as a library
- Outcome

3 Assessment of user's code

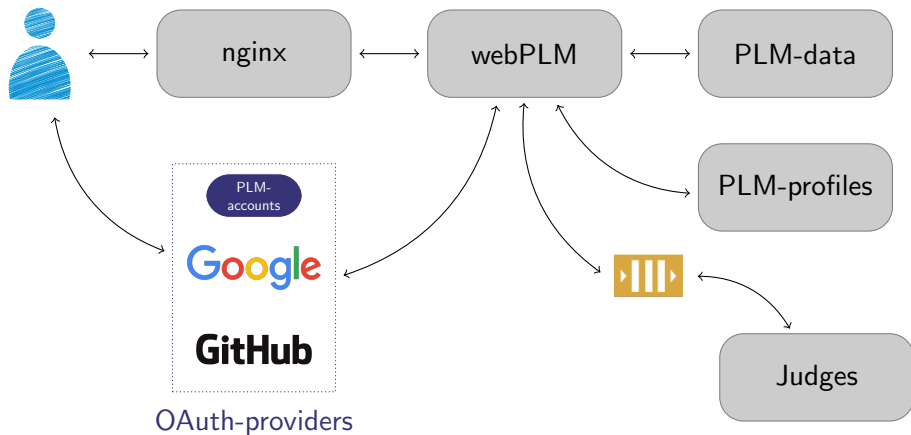
- Challenges
- Extraction of the execution component
- Docker

4 Result

5 Next steps

Result

Current architecture



Result

Live-session in TELECOM Nancy

- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students

Result

Live-session in TELECOM Nancy

- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students
- Engine is (almost) working fine...
- ... but user experience needs to be improved!

- Scalability issues:
 - Work well with small exercises
 - Can't cope with workload of larger exercises

Result

Live-session in TELECOM Nancy

- Scalability issues:
 - Work well with small exercises
 - Can't cope with workload of larger exercises
- No tools for monitoring set up...

Result

Live-session in TELECOM Nancy

- Scalability issues:
 - Work well with small exercises
 - Can't cope with workload of larger exercises
- No tools for monitoring set up...
- ... so the bottleneck is unknown.

Outline

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Next steps

Refactor the code

- Rushed to release a stable version before September 2015...
- Needed to clean some parts of the code
- Merged local and centralized mode branches

Next steps

Simplify workflow to adapt the content

- Store most of content inside PLM-engine
- Heavy and error prone workflow
- Need to extract the content from PLM-engine's jar
- Allow to implement an exercise editor

Next steps

Solve performance issues

- Set up some monitoring tools
- Perform some load testing to identify the bottleneck

Next steps

- Integrate interns' contributions
- Set up Continuous Deployment
- Support additional programming languages
- Implement a debug mode similar to popular IDEs' ones
- Add features to help teachers to supervise their students
- ...

Thanks for your attention, any questions?